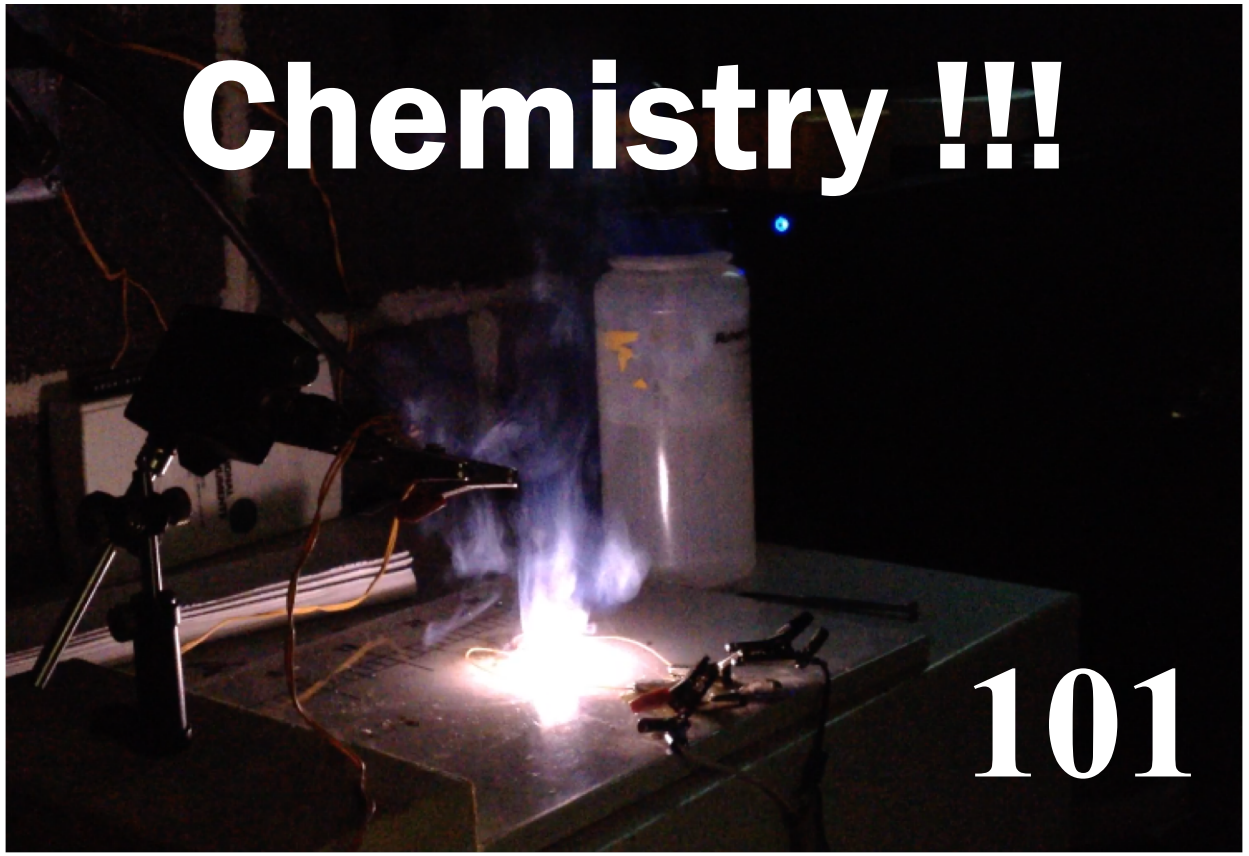


Fall 2019

Dr. Maria A. Donnelly
Beaupre 117C
madon@uri.edu

Why Learn Chemistry?

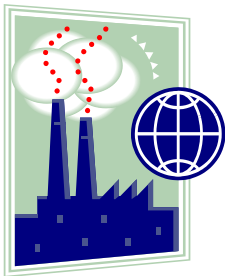
To better understand the environment around us

Medicine

- Understanding disease
- Develop new drugs

Environmental Science

- Ozone layer
- Global warming
- Acid rain



Agriculture

- Bioengineered food
- Fertilizers

Criminal Justice & Safety

- Forensics
- Explosives & Drug detection
- Safety equipment

Material Science

- Better built houses
- More efficient cars
- Plastics, composites

Why Learn Chemistry?

Fun!

Fireworks!

New materials for sports equipment!

Better electronic devices & gaming systems!

High tech clothing for any activity!

tibettravel.org

Expectations

CHM101 – Freshman Chem. Lecture (lab – CHM102)

- Required if 3-4 semesters of chem. required by major
- Pharmacy, Engineering, Biology
- Pre-professional programs: med, dental, veterinary etc.
- Some environmental science groups
- **Emphasis on mathematical skills (esp. algebra) & problem solving** (most exams ~ 80% math)
- Other General Chemistry courses – 103, 191
- Grading:
  - Connect on-line homework & Learnsmart + Quizzes(15%)
  - Four lecture exams (68%)
  - Final exam (17%)
  - to calculate: (HW avg * 0.15) + (exam avg * 0.85)
- Details in syllabus

Your choices will determine your level of success

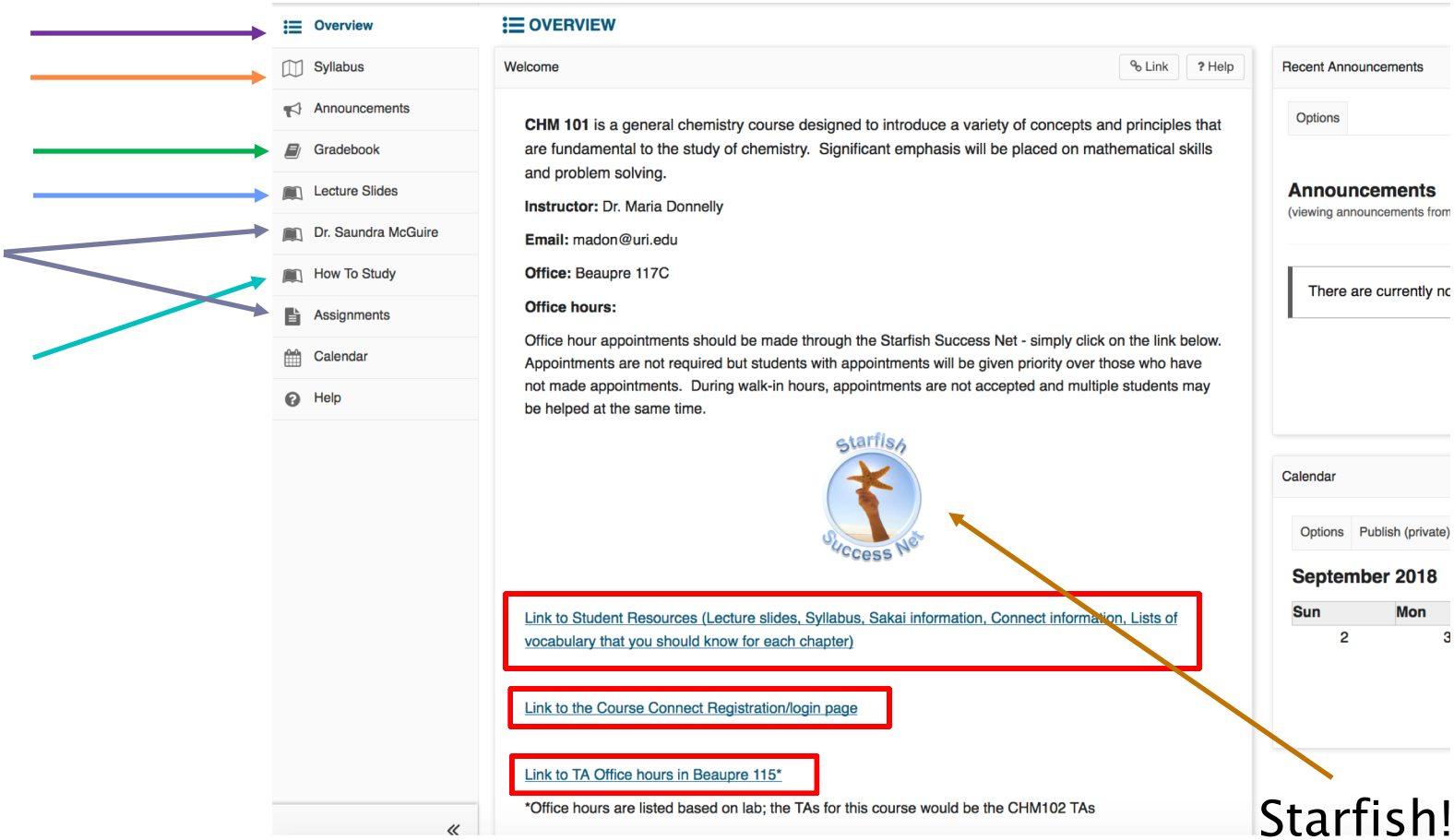
- **Attendance is important**
  - prepare in advance – become familiar with key terms & ideas
  - pay attention, ask me questions
  - print out slides and bring them with you to take notes on
- **Assignments are designed to help you learn**
  - focus on WHY you need to follow certain steps to solve problems rather than trying to memorize the steps
  - ask yourself what you do and do not understand
- **Complete assignments on time**
  - mastery of early material will help with material covered later
  - avoid having assignments build up & losing points due to lateness
- **Seek help right away!**
  - office hours & **RECITATION SESSIONS**!
  - TAs in Beaupre 115 Learning Center
  - AEC tutoring group or walk in tutoring

Be Courteous to Your Classmates

- If you arrive late/need to leave early, use the back entrance
- Your peers can be a great resource, but please wait till after lecture to talk with them/ask them questions
- Give everyone a chance to answer
- Remember why you are here
  - TV shows, games, movies, & social media will not help you learn
  - they are also visible to the students sitting behind you & can be quite distracting

Useful Information: Sakai

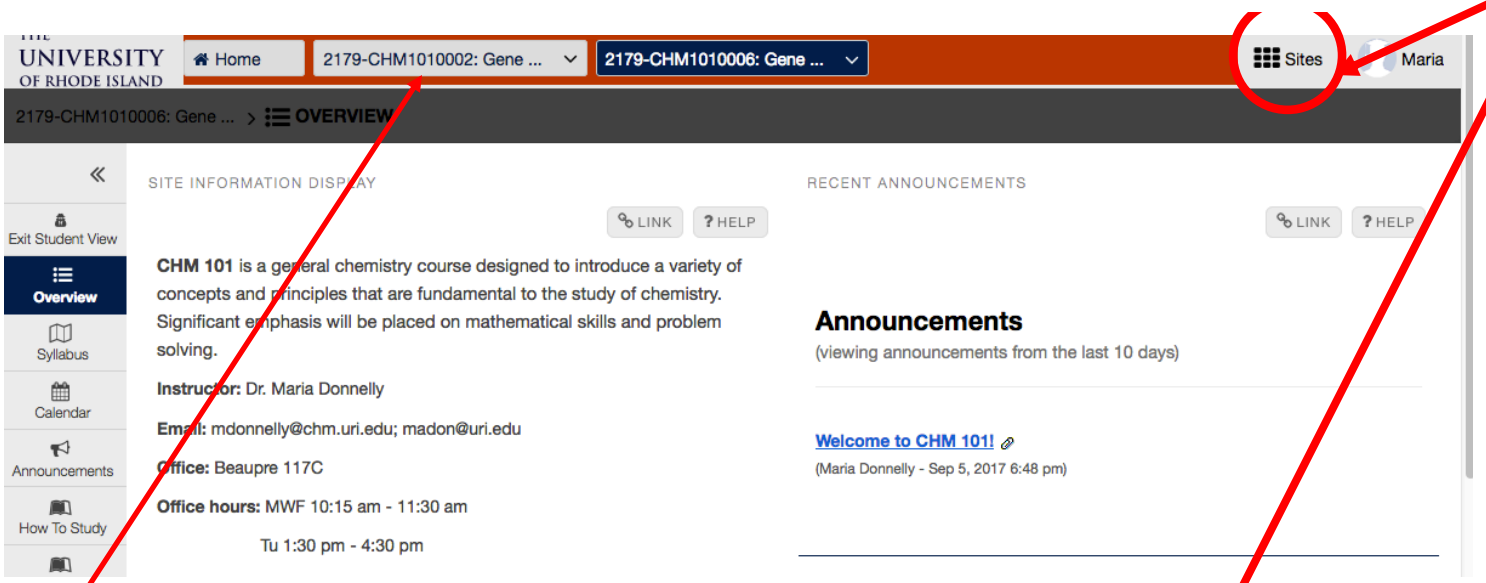
Where to find lecture slides & other useful information

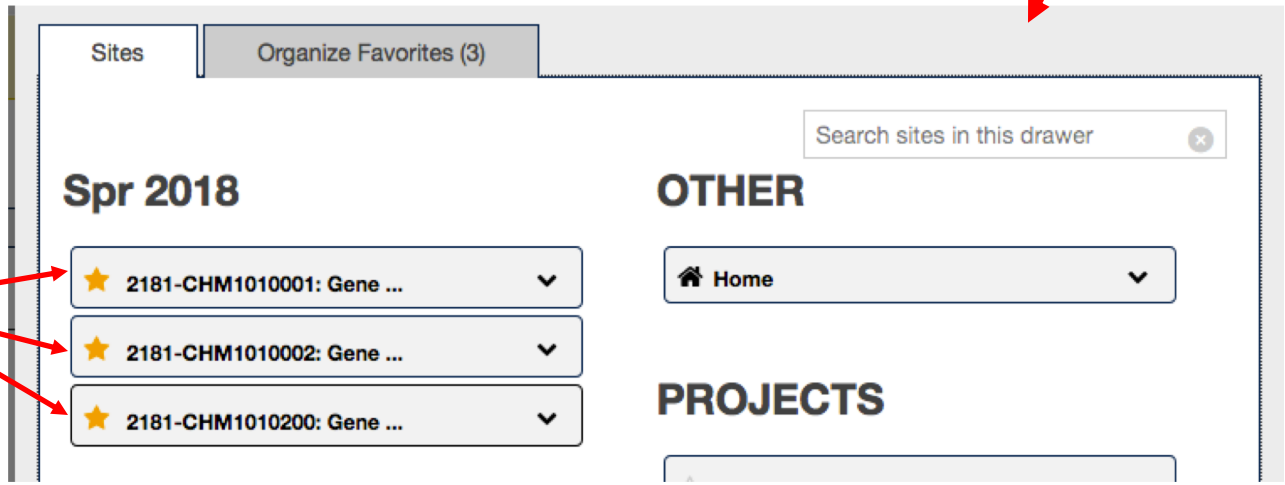


Starfish!
For making appointments, etc.

Useful Information: Sakai

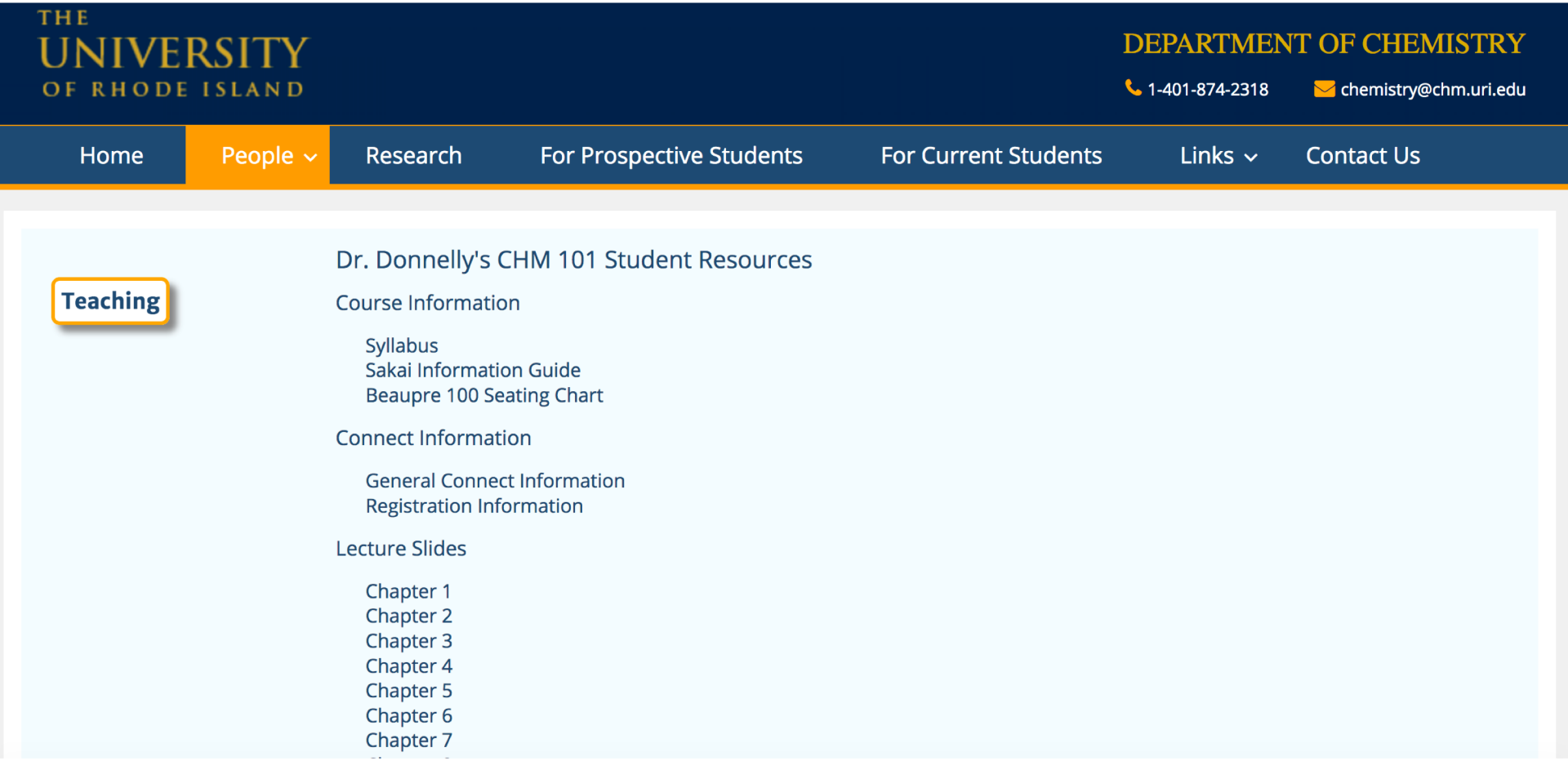
Adding (or removing) courses from tabs in Sakai





Yellow stars will show up as tabs

Useful Information: Lecture Notes, etc.

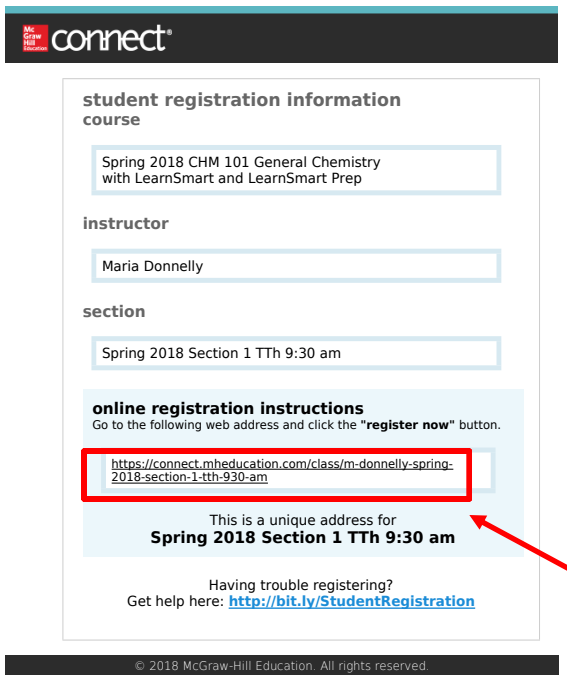


Useful Information: Connect

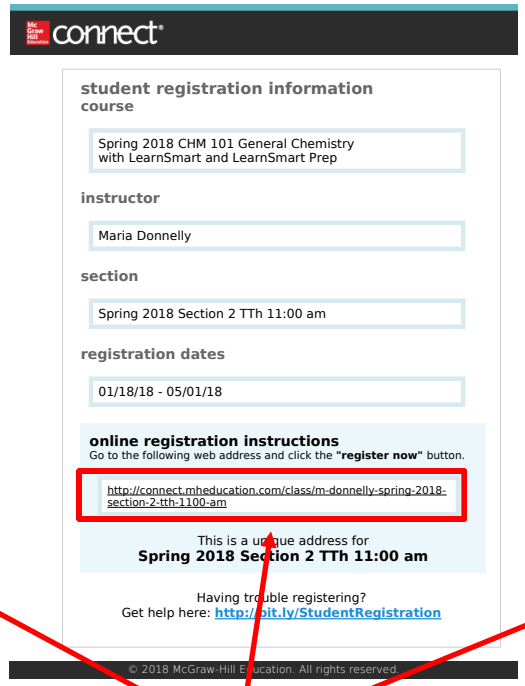
Registration Information is section specific!

Your Section!

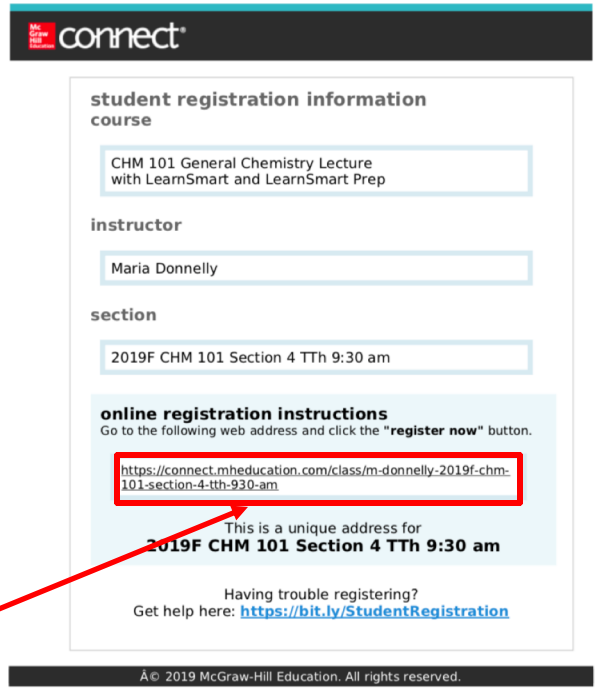
Section 1: Spring 2018 TTh 9:30 am



Section 2: Spring 2018 TTh 11:00 am

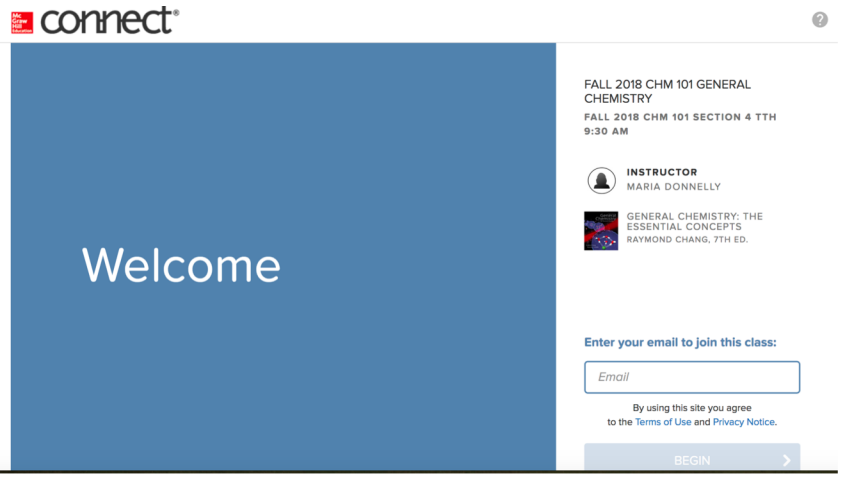


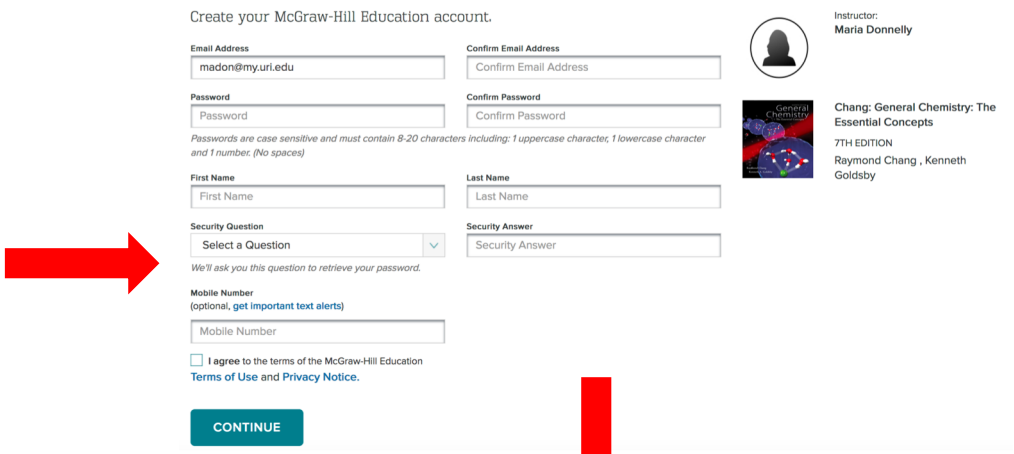
Section 4: TTh 9:30 am

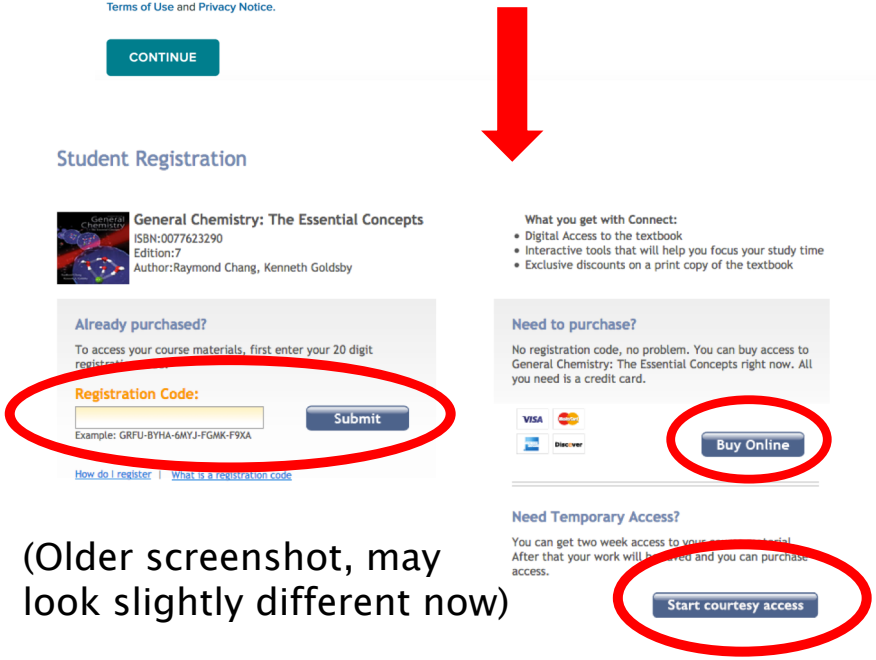


Link to registration page

Useful Information: Connect Registration





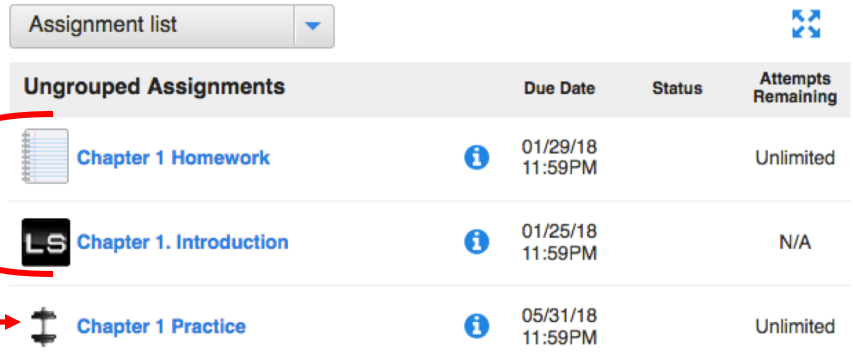


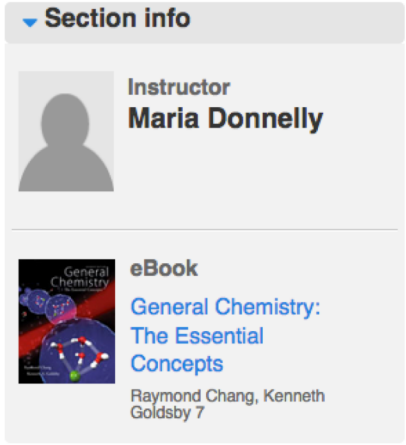
(Older screenshot, may look slightly different now)

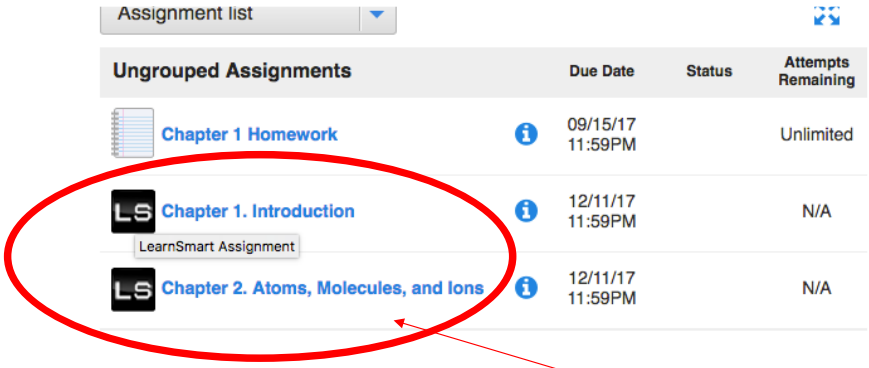
Useful Information: Connect Assignments

Required

NOT Required



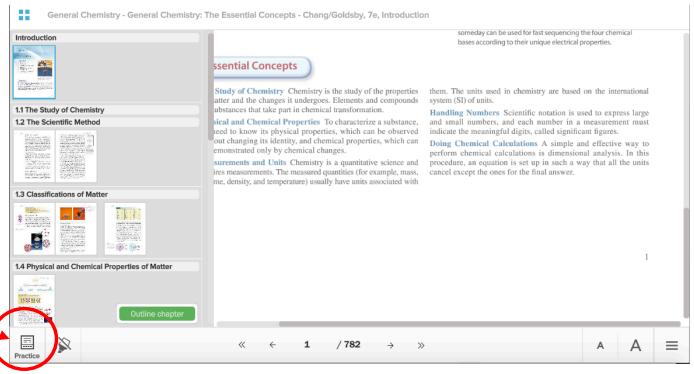




LS = Learnsmart

Learnsmart assignments for chapters 1 & 2

Link to Learnsmart practice problems



Chemistry Labs Start This Week!!!

Safety Training is required for all Chem. Labs

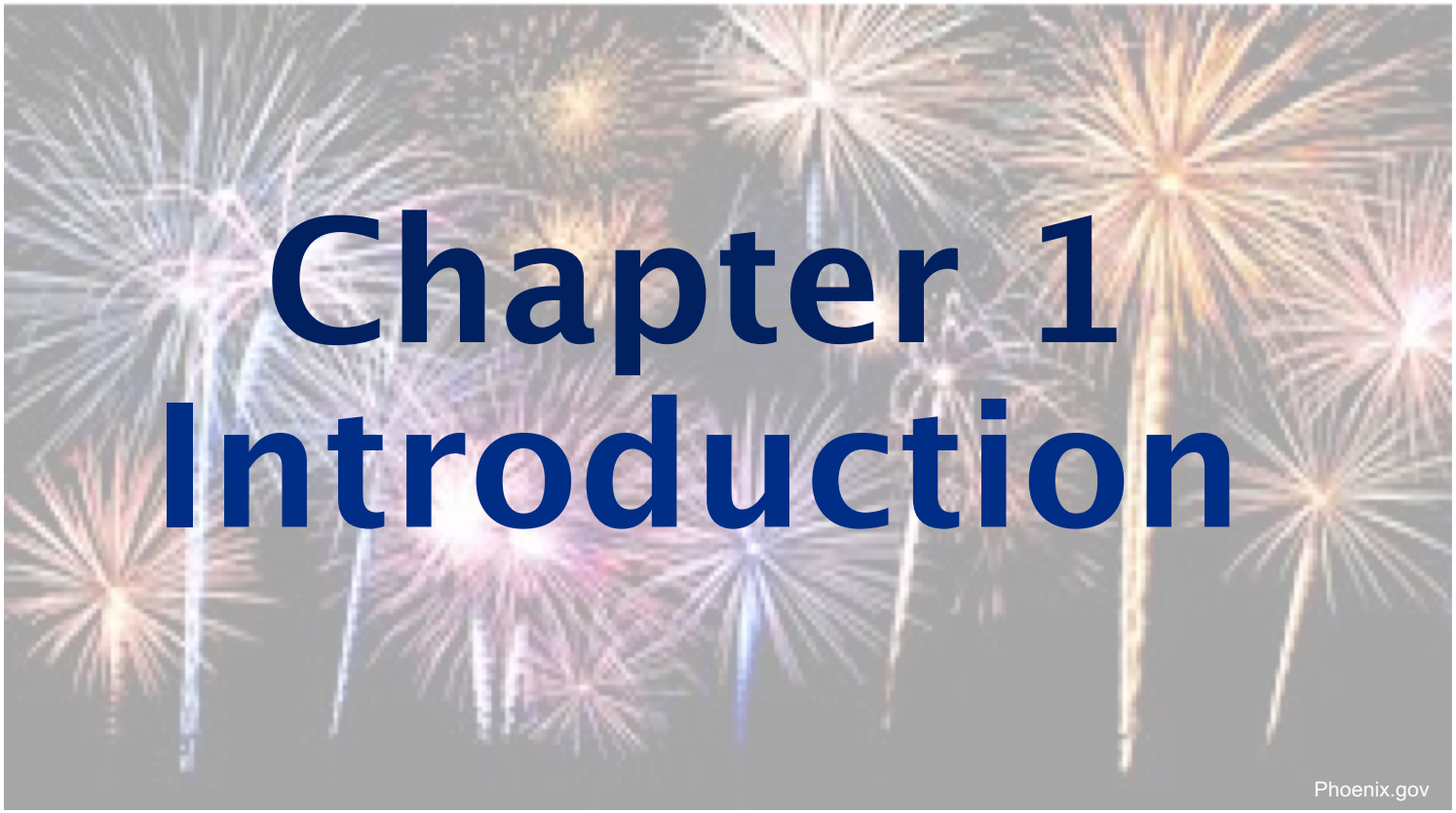
You must complete the required on-line lab safety module before your second lab session or you will not be able to participate in that lab – CHM 102 has only ONE make-up lab!

If you miss your first lab:

1. Attend a makeup lab session by **Tuesday September 9th,** ideally in the same room
2. You must attend a safety training specific to your course (see ecampus for times)
3. Attend your assigned lab next week

If you want to get into a lab:

1. Complete the safety module and add your name to the Wait List at www.chm.uri.edu
2. Attend a safety training session
3. You will be emailed a permission number if an opening becomes available


Chapter 1
Introduction
Phoenix.gov

The science that studies the properties of substances & how substances react with one another.

How stuff works on a molecular/atomic/subatomic level

Chemistry!

MATTER

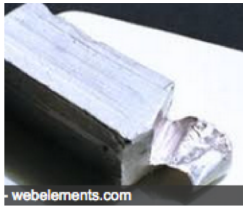
Has mass & takes up space

ENERGY

The capacity to do work or cause change

REACTIONS

How materials interact & change



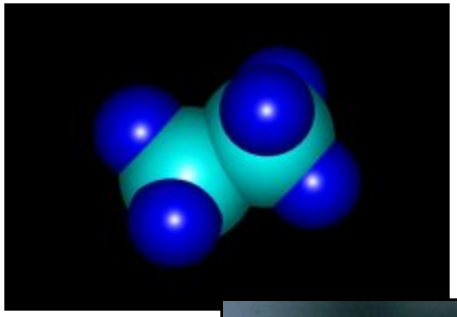
+

Learning the Language

Chemistry describes materials and predicts behavior using three basic concepts

Composition

- Mass percent of elements/compounds present
- Atomic/molecular ratios within material
- Stoichiometry



Structure

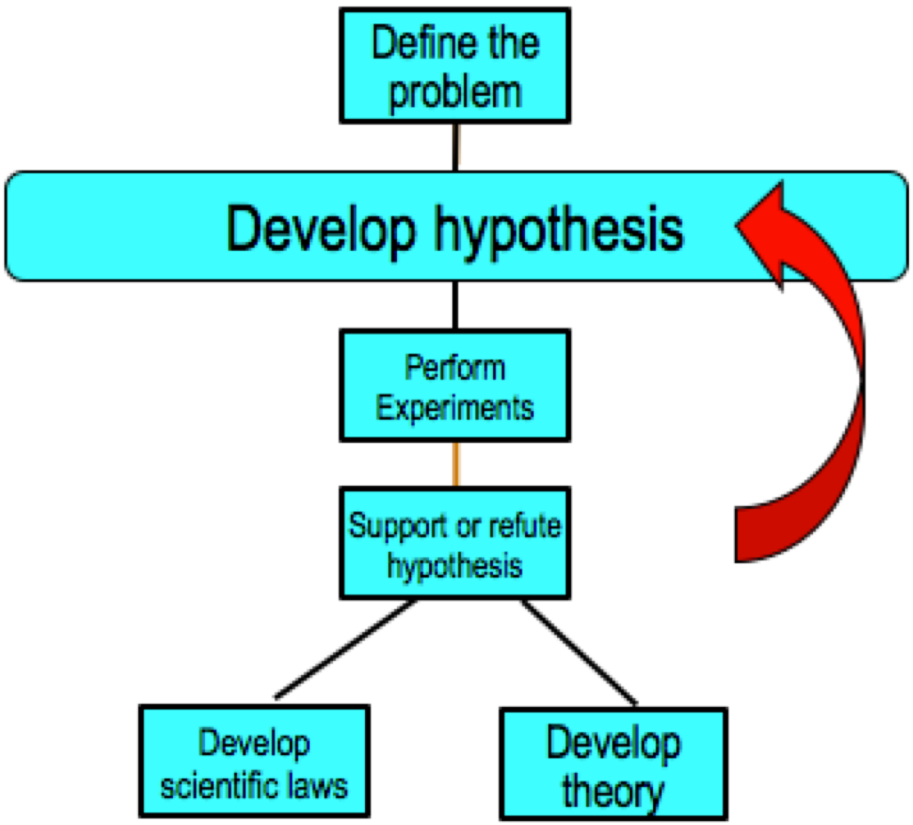
- Molecular/ionic/atomic arrangement
- Phase (solid, liquid, gas)

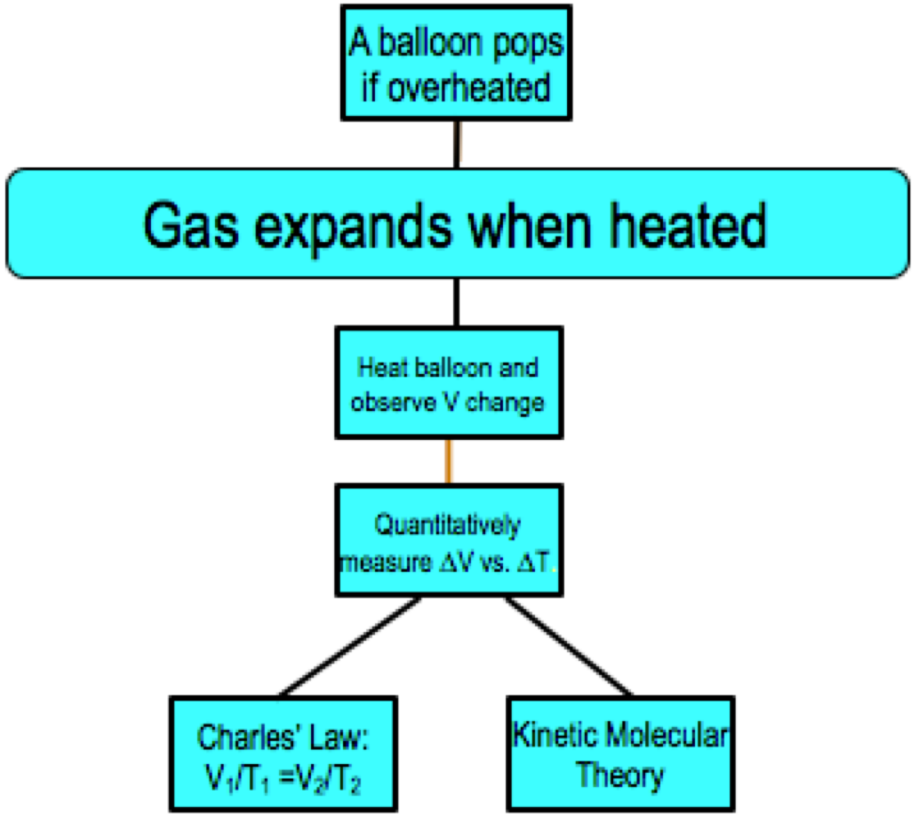
Properties – chemical & physical

- Specific to a particular material
- ex: boiling point, color, odor, reactivity
- Used for identification

The Scientific Method

Series of steps that explain an observation





Molecules move faster when heated requiring more space, causing balloon to pop.

Classifications of Matter

What is in the material you are investigating?

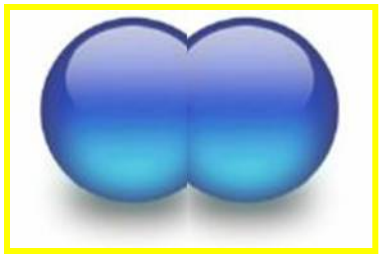
Pure materials

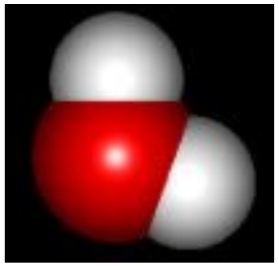
Atom:

- Smallest distinctive unit w/ properties of element

Molecule:

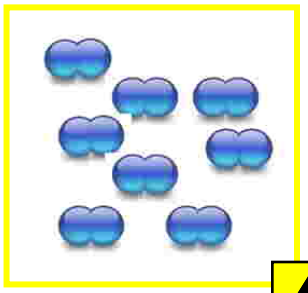
- 2 or more atoms together



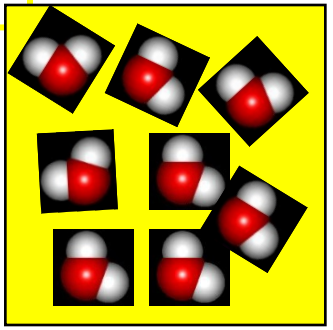


Pure Substance:

- Definite/constant composition & distinct properties
- **TWO** types of pure substances:
  - **Element** → one type of atom



  - **Compound** → more than one type of atom chemically bonded
    - Compounds contain more than one element – still a pure substance!!!



Mixtures

Mixture: Combination of 2 or more pure substances

- Can be separated by physical means

Homogeneous Mixture

- Substances stay mixed
- No distinct layers
- Uniform properties
- **Also called a "solution"**

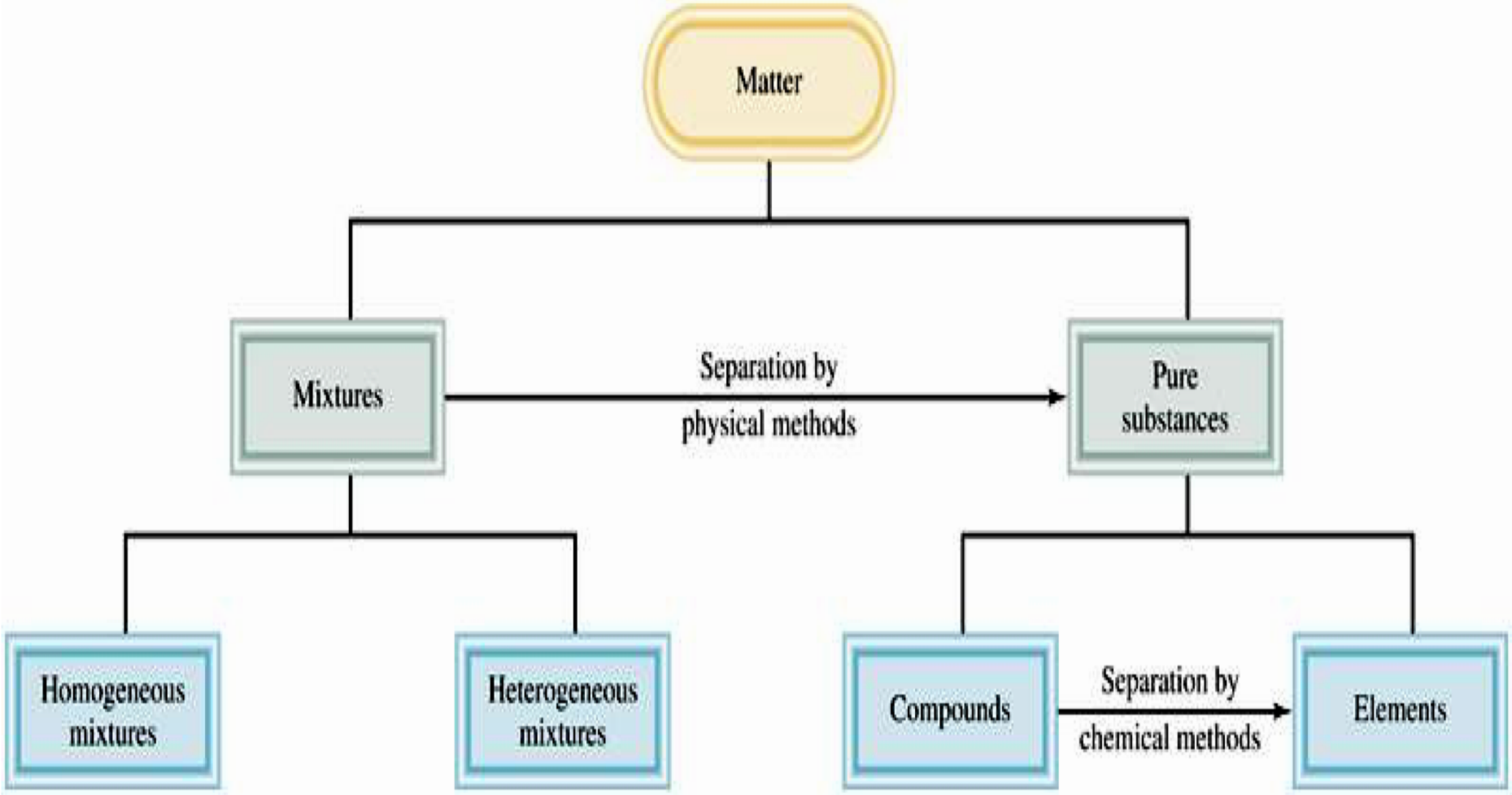
14 karat gold
Mixture of gold and silver

Heterogeneous Mixture

- Substances separate easily
- Distinct layers often seen
- Properties may not be uniform

Iron filings and sand

Matter Summary



	Heterogeneous mixture	Homogeneous mixture	Pure Substance
			
			
			
			
			
			

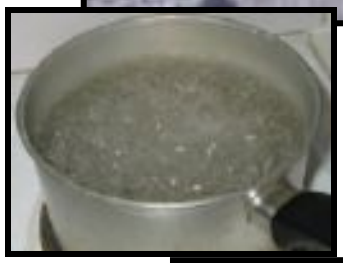
Physical and Chemical Properties of Matter

Can be used to identify & separate substances

Physical Properties of Matter

Can be changed without changing molecular composition

Chemical identity is NOT CHANGED
eg: smashing a window – still glass
melting ice – still water



Phase changes are physical changes
(solid to liquid to gas etc.)
Melting, freezing, boiling, etc.
CHEMICAL BONDS ARE NOT BROKEN DURING PHASE CHANGES!

Can be used to ID a substance without damage
Color, odor, solubility, conductivity, density
molecular mass, boiling/melting points
Original compound can be recovered

Chemical Properties of Matter

Describe how chemicals react with each other

What will they react with?

How will they react?

- Generate heat or light?
- Burn? Explode?
- Decompose slowly? (Rusting, rotting)

Compositional changes to molecules

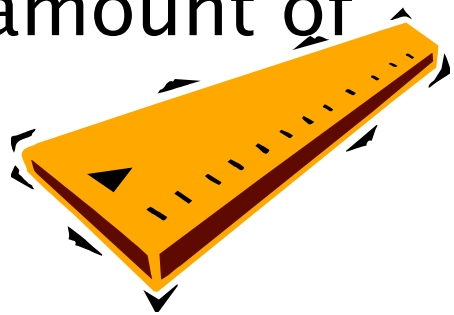
- Often called a chemical change
- Original material changed on an atomic level

Original compound no longer present

- Compound cannot be restored to its original form without another chemical change

Extensive and Intensive Properties

Extensive Property: Depends on amount of matter present



ex: mass, length, volume, heat, intensity of color or odor

Intensive Property: Independent of amount of matter present

ex: Temperature, boiling point, color, odor

Often a calculated ratio

ex: Density (mass/vol ratio)

Molar mass (grams/mol)

Specific heat (J/g)

Intensive properties can be used to identify a material, extensive properties cannot. Why?

Measurements

Determining how much matter is present

olin.edu

amazon.com

Base Units of Measurement International System of Units (SI)

TABLE 1.2 SI Base Units

Base Quantity	Name of Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electrical current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol

Will be used frequently in CHM 101; you are expected to know them! (Depending on other classes, will likely need to know ampere in the future.)

SI Prefixes

Yes, you need to know these too

TABLE 1.3 Prefixes Used with SI Units

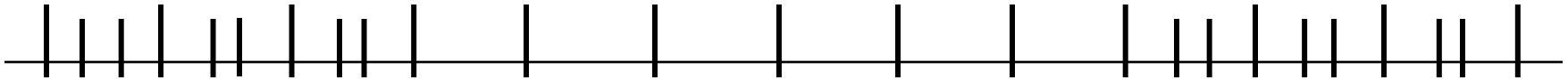
Prefix	Symbol	Meaning
tera-	T	1,000,000,000,000, or 10^{12}
giga-	G	1,000,000,000, or 10^{9}
mega-	M	1,000,000, or 10^{6}
kilo-	k	1,000, or 10^{3}
deci-	d	1/10, or 10^{-1}
centi-	c	1/100, or 10^{-2}
milli-	m	1/1,000, or 10^{-3}
micro-	μ	1/1,000,000, or 10^{-6}
nano-	n	1/1,000,000,000, or 10^{-9}
pico-	p	1/1,000,000,000,000, or 10^{-12}

hecto (10^2)
deca (10^1)
Base

The Great Majestic King Henry Died By Drinking Chocolate Milk at Mad Nick's Palace

The Great Majestic King Henry Died By Drinking Chocolate Milk at Mad Nick's Palace

Metric System is Base 10 – essentially just moving the decimal point



tera	giga	Mega	kilo	hecto	deca	base	deci	centi	milli	micro	nano	pico
(10^{12})	(10^{9})	(10^{6})	(10^{3})	(10^{2})	(10)	(1)	(10^{-1})	(10^{-2})	(10^{-3})	(10^{-6})	(10^{-9})	(10^{-12})

25 m = 0.000000000025 Tm
25 m = 0.000000025 Gm
25 m = 0.000025 Mm
25 m = 0.025 km
25 m = 0.25 hm
25 m = 2.5 dam
25 m = 25 m
25 m = 250 dm
25 m = 2500 cm
25 m = 25000 mm
25 m = 25,000,000 μm
25 m = 25,000,000,000 nm
25 m = 25,000,000,000,000 pm

25 Tm = 25,000,000,000,000 m
25 Gm = 25,000,000,000 m
25 Mm = 25,000,000 m
25 km = 25,000 m
25 hm = 2500 m
25 dam = 250 m
25 m = 25 m
25 dm = 2.5 m
25 cm = 0.25 m
25 mm = 0.025 m
25 μm = 0.000025 m
25 nm = 0.000000025 m
25 pm = 0.000000000025m

Metric Conversion Examples

1.) Convert 256.74g to kg
(0.25674 kg)

2.) How many milliliters are in 3.78 L?
(3780 mL)

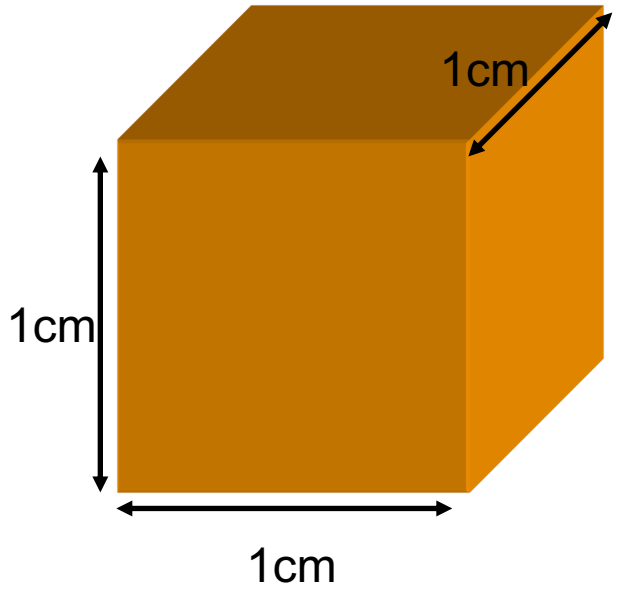
3.) Convert 18000000 cm into Mm
(0.18 Mm)

Derived Units: Volume

SI derived unit for volume is a cubic meter (m^3)

Common unit is a "**Liter (L)**"

$$1L = 1000cm^3 = \frac{1000cm}{1} x \frac{1cm}{1} x \frac{1cm}{1} x \frac{1m}{100cm} x \frac{1m}{100cm} x \frac{1m}{100cm} = 1x10^{-3}\,m^3$$



1 L ≠ 1 m^3

1L = 1x$10^{-3}$$m^3$

1 mL = 1 cm^3

Metric Conversions with Units that are squared (s^2), cubed (cm^3), etc. can be tricky:

ex.) Convert 87856 cm^3 to m^3

Note: 1 m = 100 cm but $1 m^3 \neq 100 cm^3$

Need to do the conversion 3x for cubed numbers

(2x for squared, etc.)

$87856 cm^3 = 0.087856 m^3$

Derived Units: Density

Density: Ratio of mass to volume of a material

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{m}{V}$$

SI derived unit for density is kg/m^3

$1\ g/cm^3 = 1\ g/mL = 1000\ kg/m^3$

Substance	Density (g/cm^3)
Air*	0.001
Ethanol	0.79
Water	1.00
Mercury	13.6
Table salt	2.2
Iron	7.9
Gold	19.3

Intensive property

- Can be used to identify a material
- Units of mass and volume may vary

Handling Numbers

Math Review

Significant Figures:

Number of Digits to Report in Final Answer

1. All non-zero digits are significant
2. Use decimal point to decide if zeros are significant

Between 2 numbers	significant	50.002	5 sig figs
Before decimal point	not significant	0.502	3 sig figs
Before the first digit	not significant	0.0052	2 sig figs
End of # after decimal	significant	0.0200	3 sig figs
No decimal point:	not significant	500	1 sig fig

3. **Exact** numbers have unlimited number of sig. figs.

Inherently an integer:	e.g. 4 sides to a square
Inherently a fraction:	e.g. ½ of a pie
Obtained by counting:	e.g. 47 people in a class
Defined quantity:	e.g. 12 eggs in a dozen

Determining the correct number of significant figures (sigfigs) in math problems:
Answer is based on the LEAST significant value

Addition/subtraction – Sig figs based on decimal

$$\begin{array}{r} 1500 \\ +\ 2976 \\ \hline 4476 \end{array} \longrightarrow 4500$$

$$\begin{array}{r} 12.45\text{XX} \\ -\ \ 9.2680 \\ \hline 3.1820 \end{array} \longrightarrow 3.18$$

Multiplication/Division – Sig figs based on all sig digits

4 sig figs — 3 < 4 so 3 sig figs

$$3.182 \times 3.57 = 11.35974 \longrightarrow 11.4$$

3 sig figs

Rounding is based on number <u>after</u> last sigfig:

≥ 5 round up ≤ 5 round down

Multiple math functions – follow order of ops

$$(12.45 - 9.2680) \times 3.575 = 11.37565$$

Step one: Subtraction → Sigfigs based on decimal

(12.45 - 9.2680) = 3.182

2 sigfigs after decimal

3 sigfigs overall in final answer

$$\begin{array}{r} 12.45\text{XX} \\ -\ \ 9.2680 \\ \hline \mathbf{3.18}20 \end{array}$$

Step two: Multiplication → Sigfigs based on all sig digits

$$\mathbf{3.18}2 \times 3.575 = \mathbf{11.3}7565$$

3 sigfigs in 1st number, 4 in 2nd → 3 in final answer

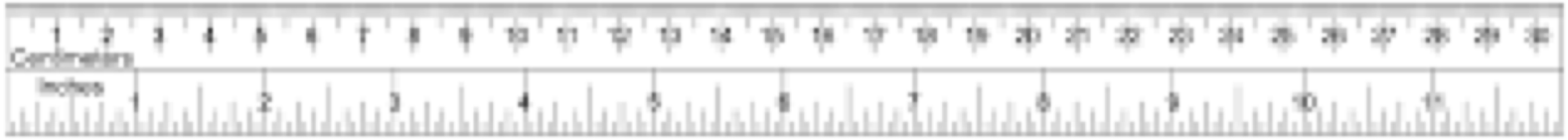
Here addition limits sigfigs

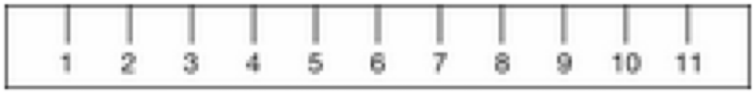
Round up because the next number is >5

11.37565 → 11.4

Why do significant figures matter?

123.52 cm





121 cm

Width of room: 244.6 cm
Will the two desks fit?

$$\begin{array}{r} 123.52 \text{ cm} \\ +\ 121.?? \text{ cm} \\ \hline 244.52 \text{ cm} \end{array}$$

Fitting desks in a room may not seem all that important – but the same concept is true for the design of buildings & bridges!

Scientific Notation

For very large or very small numbers

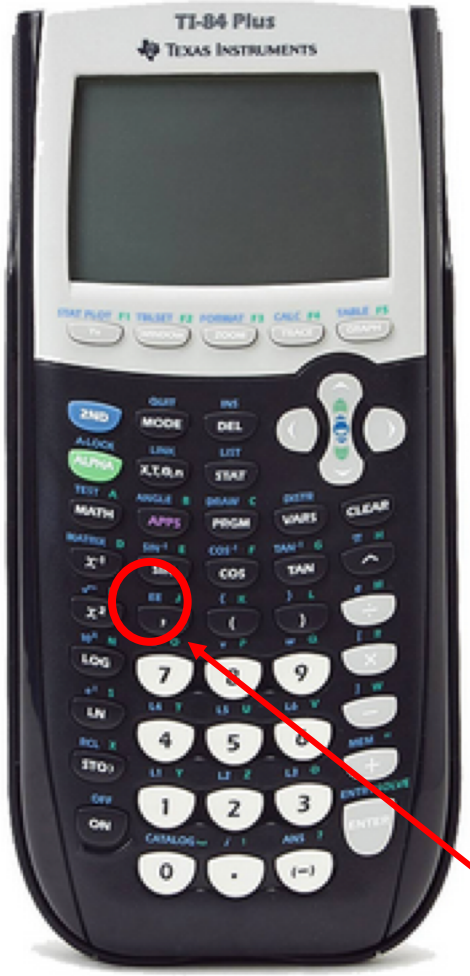
Significant digits ⟶ 1.7×10^{6} ← Size of number (multiplier)

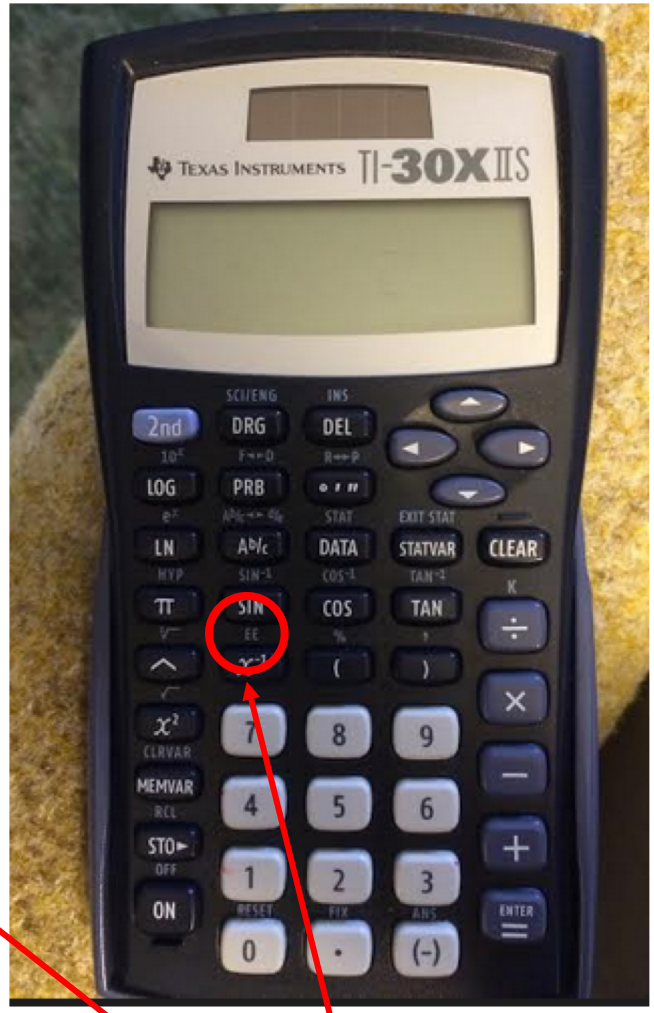
$1700000 \rightarrow 1.7 \times 10^{6}$ ⟵ Positive exp = large number (>1)

$0.0000017 \rightarrow 1.7 \times 10^{-6}$ ⟵ Negative exp = small number (<1)

Rules:

- Keep all significant numbers
- Place decimal after 1st significant number (1.7)
- To get exponent:
  - Count number of places decimal moved to get to correct location (after 1st significant number). This value is your exponent.
  - If the number is >1, exp is positive $1700000 \rightarrow 1.7 \times 10^{6}$
  - If the number is <1 exp is negative $0.0000017 \rightarrow 1.7 \times 10^{-6}$





Use EXP, SCI, EE or $x10^x$ keys on calculator

Scientific Notation Examples

Write the Following in Scientific Notation:

1.) 280000000

2.) 280.0

3.) 0.000000004577

4.) 0.00000060

Write the Following in Standard Format:

1.) 2.45×10^{2}

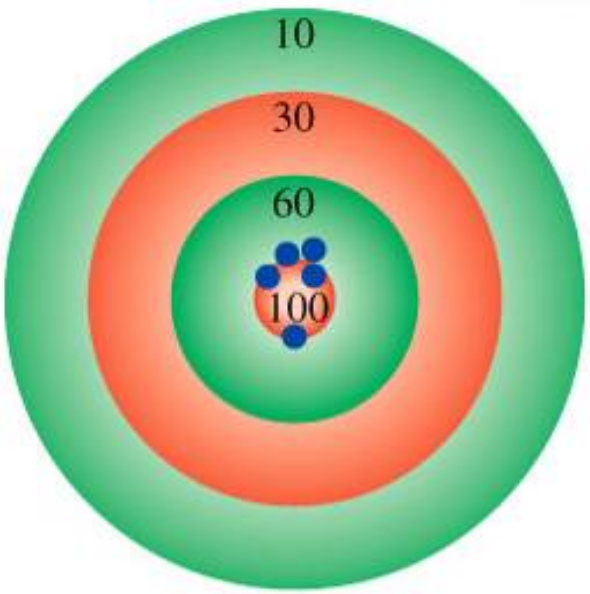
2.) 3.98×10^{6}

3.) 4.29×10^{-3}

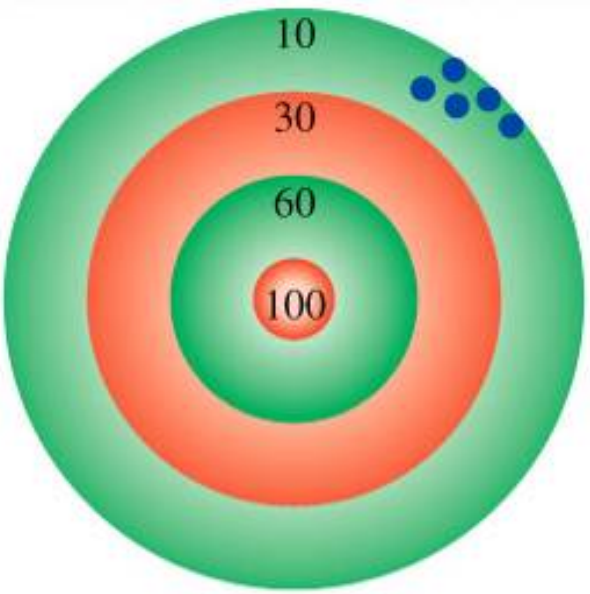
4.) 8.0×10^{-6}

Precision and Accuracy

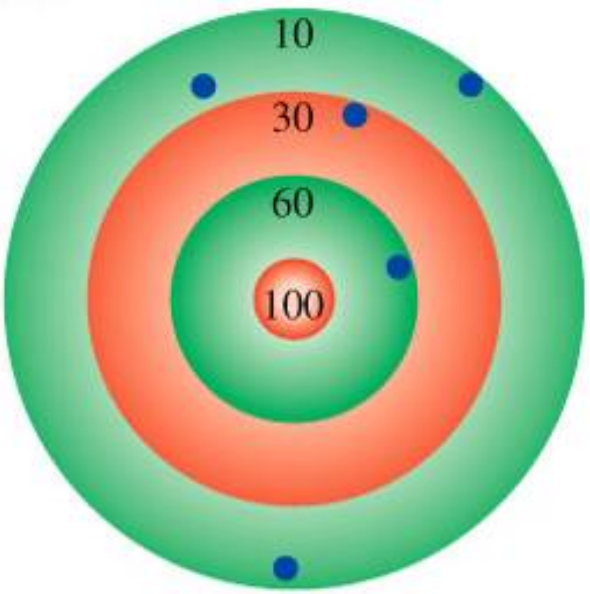
Accuracy – how close a measurement is to the true value
Precision – how close measurements are to each other



accurate
&
precise



precise
but
not accurate



not accurate
&
not precise

Percent Error

Comparison of experimental results to expected or real values

- Usually reported without a + or - sign

$$\% \text{ error} = \left(\frac{|\text{Experimental value} - \text{Real value}|}{\text{Real value}} \right) \times 100$$

Experimental value - Real value = **Deviation**

- Often reported with a + or – sign

Real value:

- Widely accepted, often an industry standard value
- Average of several experiments can sometimes be used if real value is unknown

Dimensional Analysis
Algebra and canceling units

Look at question:

How many kilograms of methanol will fill a 15.5 gallon fuel tank of a car modified to run on methanol? (Density of methanol = 0.791 g/mL)

What unit do you want to solve for?

What information do you need?

Data in problem:

Data to look up:

Data to know:

Dimensional Analysis Problems

1) How many kilograms of methanol will fill a 15.5 gallon fuel tank of a car modified to run on methanol? (Density of methanol = 0.791 g/mL; 1 gal = 3.785 L) A: 46.4 kg

2) How many liters are equal to 500. cm^3? A: 0.500 L

3) A cube with sides measuring 7.50 m has a mass of 0.04567 mg. What is the density of the cube in μg/mL? A: 1.08×10^{-7} μg/mL